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## (54) AN APPARATUS FOR REDUCING MATERIALS.

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**EP-A- 0 174 148**
**SE-B- 372 897**
**SE-B- 437 477**

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## Description

The present invention relates to an apparatus for reducing materials such as organic waste, very bulky waste like refrigerators, tyres, furniture, tree stumps, demolition timber or the like, wherein said apparatus includes reducing means consisting of U-shaped knives situated in a plane perpendicular to the axis of rotation for the shafts and which are arranged evenly along and around two substantially parallel and horisontal shafts which are driven by a motor being able to drive the shafts in opposite directions and which are situated with a mutual distance a little wider than the double distance between the radially outer point of a knife and the axis of rotation, driving means are arranged between the motor and the shaft, said material is supplied to the knives through an inlet disposed above the knives, said knives co-operate with knives fixedly mounted between said shafts on a part of the frame of the apparatus for reducing the material when said shafts rotate in opposite directions whereby the cutting edge of the blades is moved towards each other at the upperside of the fixed knives.

In several situations a reduction of materials is desirable. In industrial utilization of useful raw materials as e.g. wood there will be a surplus of useless wood waste including the root. The waste product may leave the producer with major disposal problems. Furthermore, it is desirable to reduce the volume of domestic waste in order to mimimize the need for storage capacity. The reduction of the volume is also desirable in connection with transportation. Furthermore, it is often desired to reduce waste materials prior to combustion, composting or reuse of these materials.

An apparatus of the type described above is known e.g. from US patent No. 3,845,907 in which the knives mounted on one shaft co-operate with the knives of the other shaft. Furthermore, this patent discloses a time or torque dependent reversing capability for the motor. However, such reversal may not be effected on each shaft independent of the other shaft.

From European patent application published under No. 174,148 another apparatus is known in which the knives cooperate with fixedly mounted knives on the frame. However, the shafts are not arranged for individually rotational speeds and sequences of rotation. The capacity of such known apparatus is limited.

From SE-B-437,477 an apparatus of the above type is known. However, this apparatus does not include U-shaped knives. This apparatus suffers from the same drawbacks as the apparatus described in EP No. 174,148. This apparatus may be the user will not be sure that the material will be reduced even though it has passed through the apparatus.

Accordingly, the problem with efficient and economical reduction of the materials has not been solved in a satisfactory manner.

It is the object of the present invention to remedy this problem and to provide an apparatus for efficient and economical reduction of materials irrespective of the material consisting of an inhomogeneous composition, like e.g. organic waste or of very bulky waste.

According to the present invention this is achieved with an apparatus of the type mentioned above which is characterized in that the mutual distance between the two shafts is a fixed distance, and that the driving means arranged between the motor and the shafts comprise a suitable gear for each of said two shafts, a hydraulic motor with adjustable speeds of rotation for activating each shaft, an adjustable pump for feeding each hydraulic motor, and gears through which the motor activates said pumps which are able to revert the flow through the hydraulic motors to rotate each shaft individually forwards and backwards according to a predetermined sequence.

During their rotation the knives will perform a reduction in the form of a cutting through and a carrying along of the materials which are placed on the frame of the apparatus in a feed funnel. Due to the positioning of the knives the material is carried along evenly without the risk that a large amount of material from time to time is introduced between the rotating knives and the fixed knives. This even carrying and the consequently even reduction of the material may be ensured by positioning the knives about the two shafts in a random manner or helically. When, at the upperside of the frame, the cutting blades are moved towards each other they will carry along the material which is reduced when the edges of the cutting blades co-operate with the fixed knives. Thus in an efficient manner the knives will contribute to ensure that the material is fed, and a suitable embodiment of the knives makes it possible to adjust the quantity of the material fed relative to the capacity of the activating means and the loading which the knives may tolerate.

In order to avoid that the knives cut only a track into the material and do not perform any further carrying, the activating means of the apparatus are arranged in such a way that at intervals they may rotate the shafts individually in a direction opposite the rotating direction of the cutting movement of the knife. This forwarded and backwarded individual rotation of the shafts is established according to a predetermined sequence which is determined with due regard to the material to be

a metering of the load on the knives.

As an example of possible sequences may be mentioned a rotation with 14 revolutions in the cutting movement of the knives succeeded by 1 revolution in the opposite direction and a rotation with 10 revolutions in the direction of the cutting movement of the knives succeeded by 4 revolutions in the opposite direction. However, it is noted that any combination of forwarded and backwarded rotations is possible, but that the most efficient utilization of the apparatus is achieved if the backwarded rotation is minimized.

It is noted that the term "forwarded and backwarded rotation" refers to the rotation in the direction of the cutting movement of the knives respectively their rotation in the opposite direction.

A particular advantageous embodiment of the invention is characterized in that each knife comprises two successively arranged and substantially U-shaped blades, that the radially outer and front parts of the two blades, as seen in the rotation direction of the cutting movement of the knives, are constructed as substantially tagentially orientated wedges, that the distance between the axis of rotation and the wedge of the front blade is shorter than the distance between the the axis of rotation and the wedge of the trailing blade and that the radially outer contour of the traling blade corresponds substantially to a segment of a spiral-shaped line about the axis of rotation.

With this construction of the knives the U-shape of the two successive blades prevents the apparatus from being "overfed" thus overloading the apparatus. Each of the two U-shaped knives is capable of carrying and reducing the amount of material which is determined by the opening of the U-shaped cutting blade. As the front part of the cutting blade is also wedge-shaped, an initial splitting of the material will be performed before the cutting movement of the knives starts.

Thus only an even loading will be imparted which prolongs the life of the machine and reduces the energy requirement. Furthermore, it is noted that the different radial positionings of the two wedges of the cutting blades make it possible to perform a more efficient reduction of the material for each rotation of the shaft, than would be possible with one blade having a wedge-shaped point positioned substantially in the same manner as the wedge-shaped point of the trailing blade. The efficiency of the knives is increased as a cleaning and redistribution of the material are performed when the shaft is rotated backwards. The redistribution of the material inside the apparatus is performed in a very efficient manner as the outer contour of the trailing blade is spiral-shaped and optionally ribbed. This shape ensures that the material will not "roll" smooth and circular about the axis of rotation.

The invention will now be further explained with reference to the accompanying drawing, wherein

- Fig. 1 shows a plane view of an apparatus according to the invention,
- Fig. 2 is a side view of a knife which forms part of an apparatus according to Fig. 1,
- Fig. 3 is a sectional view through the knife shown in Fig. 2 along the plane III-III,
- Fig. 4 is a cross section through the knife shown in Fig. 2 along the plane IV-IV,
- Fig. 5 is a diagram illustrating the activating means of the apparatus, and
- Fig. 6 is a view illustrating three possible activating sequences for the shafts of the apparatus.

Fig. 1 illustrates a plane view of an apparatus according to the invention as seen from above. The apparatus 1 comprises two parallel and horizontal shafts 2. The shafts 2 are provided with knives 3. The knives 3 are mounted on the the shafts 2 by means of clamping flanges 4 so that each knife 3 runs in a plane perpendicular to the axis of rotation 5. The knives 3 which will be subject to more detailed explanation below, co-operates with lower knives 6 which are fixedly mounted on transversing beams 7 which constitute a part of the frame 1 of the apparatus. The knives 6 are located between the two shafts so that a reduction of the material is performed by the rotating knives 3 rotating from the top side past the fixed knives 6. The reduction of the material is thus performed in the area between the two shafts 2 and at the upper side of the fixed knives 6.

In order to ensure an efficient and economical reduction of the materials, the rotating knives 3 are arranged helically along each of the two shafts 2. As the shafts rotate in opposite direction thereby leading the knives 3 towards each other at the upper side of the fixed knives 6 the material is drawn into the space and into the reduction zone. This material feeding takes place in a moderate pace due to the helical position of the knives 3. This ensures an even distribution of the load on the apparatus, and thus there are no requirements for a high effect to handle momentarily large overloads.

In order to ensure an efficient reduction as well as an even supply of material the knives are constructed as explained below with reference to Figs. 2-4. Each knife 3 comprises two successively arranged substantially U-shaped knive blades 8. The radially outer and front parts 9 of the two blades, as seen in the direction of rotation 10 of the knife's 3 cutting movement, are arranged with substantially tangentially orientated wedges 12. This wedge-shape facilitates the penetration of the knives and

each of the two blades 8 has an edge 11, which runs along the inside of the U-shaped blade. The distance from the axis of rotation 5 to the wedge 12 on the leading blade as seen in the direction of rotation is shorter than the distance from the axis of rotation 5 to the wedge 12 at the trailing blade. Hereby it is ensured that each of the two blades 8 contributes to the reduction of the material and simultaneously an even distribution of the loading is achieved as the reduction process takes place in two separate operations each being performed by each of the two blades 8. Together with the helical positioning of the knives 3, this will contribute to the minimization of the effect required in order to operate the apparatus.

The radially outer contour 13 of the trailing blade follows a spiral-shaped line about the axis of rotation 5 with the radially outermost part arranged at the wedge. The risk of squeezing the material against the outer contour 13 is hereby minimized. At the trailing part 14 of the blade 3 as seen in the direction of rotation, an oppositely orientated U-shaped blade 15 with an edge 16 which contributes to the reducing when the shaft rotates in the opposite direction 10 of the cutting movement of the knife. At the oppositely orientated movement, which primarily serves to redistribute the material which is located between the two shafts, the blade 15 which is also provided with a wedge-shaped point 17, will be able to reduce the material located inside the frame of the apparatus 1 but in the area outside the two shafts 2.

The outer contour 13 may be ribbed or smooth. If ribbed, a better contact with the material is achieved and thus a better redistribution. Each knife is mounted on a shaft 2 as a stopper 18 is brought into contact with a flange 4 and is attached thereto by means of bolts 19 (cf. Fig. 1). In case a knife breaks it is easily replaced. It is also possible to readjust the apparatus for another number of knives per shaft than the shown arrangement having nine knives per shaft. The shafts 2 and the fixedly mounted knives 6 are mounted on a part of the frame of the apparatus which constitutes an independent unit which may easily be removed from the remaining part of the apparatus 1. For maintenance, it is necessary to replace only this unit following which the apparatus is ready for use.

Fig. 5 shows that via a suitable gear 20 each of the two shafts 2 is activated by separate activation means in the form of hydraulic motors 21 with adjustable speeds of rotation. The hydraulic motors 21 are fed by means of adjustable pumps 22 which via gears 23 are activated by an engine 24. The engine 24 may be a diesel-powered engine or one or several electrical motors. In the circuit leading the hydraulic oil from a container 25 to the hydraulic motors 21 a valve 26 is inserted in front of each of the motors 21. Hereby it becomes possible to meter the overload which is imparted to the knives 3 and this metering is used for regulating the speed of rotation of the shafts 2 by regulating the volume. The speed of rotation is regulated in two steps of speed, however, the regulation may also be continous. By adjusting the pumps 22, it is possible to revert the flow direction in the hydraulic circuit which runs each of the motors 21. In this way it is possible to rotate each shaft 2 forwards and backwards according to a predetermined sequence. Hereby a reduction is achieved by rotating in the one direction and redistributing the material in the opposite direction. The predetermined sequence is chosen in accordance with the material to be reduced. The motor also drives a pump 27 for the secondary functions of the apparatus which are not explained in detail as it is not necessary in order to understand the present invention.

Fig. 6 illustrates three examples of sequences for each of the two shafts 2. In each of the three examples, the lowermost parts of the graphs illustrate the rotation of the shafts in the direction 10 for the cutting movement of the knives while the uppermost parts of the graph illustrate the rotation in the opposite direction. In the first example, the time lag t1 and t2 is 5 seconds and 20 seconds, respectively. In the other example, the time lags t3 and t4 are 5 seconds and 40 seconds, respectively. In the third example the time lag t5 and t6 are 5 seconds and 40 seconds, respectively. Even though the three examples do not show any overlapping as to periods in which the two shafts rotate simultaneously in the direction opposite that of the cutting movement of the knives, this situation will thus be possible.

The material is fed at the top of the apparatus shown in fig. 1 which is suitable for reducing waste as e.g. refrigerators, tyres, organic waste, furniture or the like. During this process the two shafts 2 rotate according to a predetermind sequence. Thus it is possible for an operator to take over the steering of the rotation of the shafts if abnormal conditions occur during the reduction.

## Claims

1. An apparatus (1) for reducing materials such as organic waste, very bulky waste like refrigerators, tyres, furniture, tree stumps, demolition timber or the like, wherein said apparatus includes reducing means consisting of U-shaped knives (3) situated in a plane perpendicular to the axis of rotation for the shafts and which are arranged evenly along and around two substantially parallel and horizontal

being able to drive the shafts (2) in opposite directions and which are situated with a mutual distance a little wider than the double distance between the radially outer point (9) of a knife (3) and the axis of rotation (5), driving means (20,21,22,23) are arranged between the motor (24) and the shafts (2), said material is supplied to the knives through an inlet disposed above the knives, said knives (3) co-operate with knives (6) fixedly mounted between said shafts (2) on a part (7) of the frame of the apparatus for reducing the material when said shafts rotate in opposite directions whereby the cutting edge (11) of the blades (8) is moved towards each other at the upperside of the fixed knives (6), **characterized** in that the mutual distance between the two shafts (2) is a fixed distance, and that said driving means comprise a suitable gear (20) for each of said two shafts (2), a hydraulic motor (21) with adjustable speeds of rotation for activating each shaft (2), an adjustable pump (22) for feeding each hydraulic motor (21), and gears (23) through which the motor (24) activates said pumps (22) which are able to revert the flow through the hydraulic motors (21) to rotate each shaft individually forwards and backwards according to a predetermined sequence.

2. An apparatus according to claim 1, **characterized** in that each knife (3) comprises two successively arranged and substantially U-shaped blades (8), that the radially outer and front parts (9) of the two blades, as seen in the rotation direction (10) of the cutting movement of the knives, are constructed as substantially tagentially orientated wedges (12), that the distance between the axis of rotation (5) and the wedge (12) of the front blade (8) is shorter than the distance between the axis of rotation (5) and the wedge (12) of the trailing blade (8) and that the radially outer contour (13) of the traling blade (8) corresponds substantially to a segment of a spiral-shaped line about the axis of rotation (5).

3. An apparatus according to claim 2, **characterized** in that the two trailing blades at the rear part (14), as seen in the rotation direction (10) of the cutting movement of the knives (3), have an oppositely orientated U-shaped edge (16) which co-operates in the reduction of material during rotation opposite the direction (10) for the cutting movement of the knives (3).

4. An apparatus according to claim 1, **characterized** in that the trailing blade has a ribbed

5. An apparatus according to claim 1, **characterized** in that from 8 to 15, preferably from 9 to 12 knives (3) are used for a shaft (2) having a length of 3 metres.

6. An apparatus according to claim 1, **characterized** in that said shafts (2) and the fixed knives (6) comprise an independent unit which may be removed and/or exchanged during maintenance and re-arrangement of the apparatus.

7. An apparatus according to claim 1, **characterized** in that the knives of the two shafts are situated mutually displaced relative to each other and that a helical line formed by the knives about the two shafts is arranged substantially symmetrically about a vertical plane placed half way between the two shafts.

8. An apparatus according to claim 1, **characterized** in that the driving means (20,21,22,23) are intended to rotate the shafts (2) according to individual speeds of rotation and sequences of rotation.

9. An apparatus according to claim 1, **characterized** in that a hydraulic circuit comprises pressure switches (26) metering the load on the knives (3), and that the speed of rotation is controlled step-wise according to signals from the pressure switches (26).

10. An apparatus according to claim 1, **characterized** in that the driving means (20,21,22,23) are arranged for manual intervention in the predetermined sequence.

**Patentansprüche**

1. Vorrichtung (1) zum Zerkleinem von Materialien, wie organischem Abfall, sehr sperrigem Abfall wie Kühlschränken, Reifen, Möbeln, Baumstümpfen, Abbruchholz oder dergleichen, wobei die Vorrichtung Zerkleinerungseinrichtungen einschließt, bestehend aus U-förmigen Messern (3), die in einer zur Drehachse für die Wellen senkrechten Ebene liegen und die gleichmäßig entlang und rund um zwei im wesentlichen parallele und horizontale Wellen (2), die von einem Motor (24) angetrieben werden, der fähig ist, die Wellen (2) in entgegengesetzten Richtungen anzutreiben, und die mit einem gegenseitigen Abstand angeordnet sind, der etwas größer als der doppelte Abstand zwischen dem radialen Außenpunkt (9) eines Messers (3) und der Drehachse (5) ist, angeordnet sind, Antriebseinrichtungen (20, 21, 22, 23)

angeordnet sind, das Material den Messern durch einen über den Messern angeordneten Schacht zugeführt wird, die Messer (3) mit zwischen den Wellen (2) auf einem Teil (7) des Rahmens der Vorrichtung zur Materialzerkleinerung feststehend angebrachten Messern (6) zusammenarbeiten, wenn die Wellen in entgegengesetzten Richtungen rotieren, wodurch die Schnittkante (11) der Blätter (8) an der Oberseite der feststehenden Messer (6) aufeinander zu bewegt werden, dadurch gekennzeichnet, daß der gegenseitige Abstand zwischen den zwei Wellen (2) ein fester Abstand ist, und daß die Antriebseinrichtungen ein geeignetes Getriebe (20) für jede der zwei Wellen (2), einen hydraulischen Motor (21) mit einstellbaren Rotationsgeschwindigkeiten zum Betreiben jeder Welle (2), eine einstellbare Pumpe (22) zum Versorgen jedes hydraulischen Motors (21), und Getriebe (23), durch die der Motor (24) die Pumpen (22) betreibt, die den Fluß durch die hydraulischen Motoren (21) umzukehren vermögen, um jede Welle individuell vorwärts und rückwärts gemäß einer vorbestimmten Sequenz zu drehen, umfassen.

2. Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß jedes Messer (3) zwei hintereinander angeordnete und im wesentlichen U-förmige Blätter (8) umfaßt, daß die radial äußeren und vorderen Teile (9) der zwei Blätter, in der Rotationsrichtung (10) der Schneidebewegung der Messer gesehen, als im wesentlichen tangential orientierte Keile (12) gebaut sind, daß der Abstand zwischen der Rotationsachse (5) und dem Keil (12) des vorderen Blatts (8) kürzer als der Abstand zwischen der Rotationsachse (5) und dem Keil (12) des nachfolgenden Blatts (8) ist und daß die radial äußere Kontur (13) des nachfolgenden Blatts (8) im wesentlichen einem Segment einer spiralförmigen Linie um die Rotationsachse (5) entspricht.

3. Vorrichtung gemäß Anspruch 2, dadurch gekennzeichnet, daß die zwei nachfolgenden Blätter am rückseitigen Teil (14), in Rotationsrichtung (10) der Schneidebewegung der Messer (3) gesehen, eine entgegengesetzt orientierte U-förmige Kante (16) besitzen, die bei der Zerkleinerung von Material während Rotation entgegen der Richtung (10) für die Schneidebewegung der Messer (3), mitarbeitet.

4. Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß das nachfolgende Blatt eine gerippte Außenfläche hat.

5. Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß 8 bis 15, vorzugsweise 9 bis 12 Messer (3) für eine Welle (2) mit einer Länge von 3 Metern verwendet werden.

6. Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß die Wellen (2) und die feststehenden Messer (6) eine unabhängige Einheit umfassen, die während Wartung oder Umbau der Vorrichtung entfernt und/oder ausgetauscht werden kann.

7. Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß die Messer der zwei Wellen relativ zu einander gegenseitig versetzt angeordnet sind und daß eine schraubenförmige, durch die Messer um die zwei Wellen gebildete Linie im wesentlichen symmetrisch bezüglich einer vertikalen Ebene angeordnet ist, die auf halbem Weg zwischen den zwei Wellen liegt.

8. Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß die Antriebseinrichtungen (20, 21, 22, 23) dafür vorgesehen sind, die Wellen (2) gemäß individuellen Rotationsgeschwindigkeiten und Rotationssequenzen zu drehen.

9. Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß ein hydraulischer Kreislauf Druckschalter (26) umfaßt, die die Belastung der Messer (3) messen, und daß die Rotationsgeschwindigkeit schrittweise gemäß Signalen von den Druckschaltern (26) kontrolliert wird.

10. Vorrichtung gemäß Anspruch 1, dadurch gekennzeichnet, daß die Antriebseinrichtungen (20, 21, 22, 23) für manuelles Eingreifen in der vorbestimmten Sequenz angeordnet sind.

**Revendications**

1. Appareil (1) servant à réduire des matières, telles que des déchets organiques, des déchets très encombrants tels que des réfrigérateurs, des pneumatiques, des meubles, des souches d'arbre, des poutres de démolition ou analogues, dans lequel ledit appareil comprend un moyen de réduction, consistant en des lames en forme de U (3) situées dans un plan perpendiculaires à l'axe de rotation des arbres et qui sont agencées de façon régulière le long et autour de deux arbres (2) pratiquement parallèles et horizontaux, qui sont entraînés par un moteur (24) capable d'entraîner les arbres (2) dans des sens opposés, les arbres étant

périeure au double de la distance entre le point radialement extérieur (9) d'une lame (3) et l'axe de rotation (5), des moyens d'entraînement (20, 21, 22, 23) étant disposés entre le moteur (24) et les arbres (2), ladite matière étant fournie aux lames par une entrée disposée au-dessus des lames, lesdites lames (3) coopèrant avec les lames (6) montées rigidement entre lesdits arbres (2), sur une partie (7) du cadre de l'appareil, afin de réduire la matière lorsque lesdits arbres tournent dans des directions opposées, de manière que les arêtes tranchantes (11) des lames (8) soient rapprochées les unes des autres au niveau du coté supérieur des lames (6) fixes, caractérisé en ce que la distance mutuelle entre les deux arbres (2) est une distance déterminée et en ce que lesdits moyens d'entraînement comprennent un engrenage (20) approprié, destiné à chacun desdits deux arbres (2), un moteur hydraulique (21) possédant des vitesses de rotation réglables, afin d'actionner chaque arbre (2), une pompe réglable (22) servant à alimenter chaque moteur hydraulique (21), et des engrenages (23) par lesquels le moteur (24) actionne lesdites pompes (22), qui sont capables d'inverser l'écoulement passant par les moteurs hydrauliques (21), afin de faire tourner chaque arbre individuellement en marche avant et en marche arrière selon une séquence prédéterminée.

2. Appareil selon la revendication 1, caractérisé en ce que chaque lame (3) comprend des lames (8) disposées de façon successive et sensiblement en forme de U, en ce que les parties radialement extérieures et avant (9) des deux lames, comme on le voit dans la direction de rotation (10) du mouvement de coupe des lames, sont construites comme des pointes (12) orientées pratiquement tangentiellement, en ce que la distance entre l'axe de rotation (5) et la pointe (12) de la lame avant (8) est inférieure à la distance entre l'axe de rotation (5) et la pointe (12) de la lame arrière (8) et en ce que le contour (13) radialement extérieur de la lame arrière (8) correspond sensiblement à un segment d'une ligne en forme de spirale située autour de l'axe de rotation (5).

3. Appareil selon la revendication 2, caractérisé en ce que les deux lames arrières situées sur la partie arrière (14), comme on le voit dans le sens de rotation (10) du mouvement de coupe des lames (3), présentent un bord en forme de U (16) orienté de façon opposée, qui coopère dans un un sens opposé à la direction (10), concernant le mouvement de coupe des lames (3).

4. Appareil selon la revendication 1, caractérisé en ce que la lame arrière présente une surface extérieure nervurée.

5. Appareil selon la revendication 1, caractérisé en ce que 8 à 15, de préférence 9 à 12, lames (3) sont utilisées pour un arbre (2) présentant une longueur de 3 mètres.

6. Appareil selon la revendication 1, caractérisé en ce que lesdits arbres (2) et les lames fixes (6) comprennent un ensemble indépendant qui peut être retiré et/ou remplacé durant l'entretien et le remontage de l'appareil.

7. Appareil selon la revendication 1, caractérisé en ce que les lames des deux arbres sont situées de façon mutuellement déplacées l'un par rapport à l'autre et en ce qu'une ligne hélicoïdale formée par les lames autour des deux arbres est disposées pratiquement symétriquement autour d'un plan vertical placé à mi-chemin entre les deux arbres.

8. Appareil selon la revendication 1, caractérisé en ce que les moyens d'entraînement (20, 21, 22, 23) sont destinés à faire tourner les arbres (2) selon des vitesses de rotation et des séquences de rotations individuelles.

9. Appareil selon la revendication 1, caractérisé en ce qu'un circuit hydraulique comprend des commutateurs de pression (26), mesurant la charge exercée sur les lames (3), et en ce que la vitesse de rotation est commandée par degrés, selon des signaux provenant des commutateurs de pression (26).

10. Appareil selon la revendication 1, caractérisé en ce que les moyens d'entraînement (20, 21, 22, 23) sont agencés en vue d'une intervention manuelle dans la séquence prédéterminée.

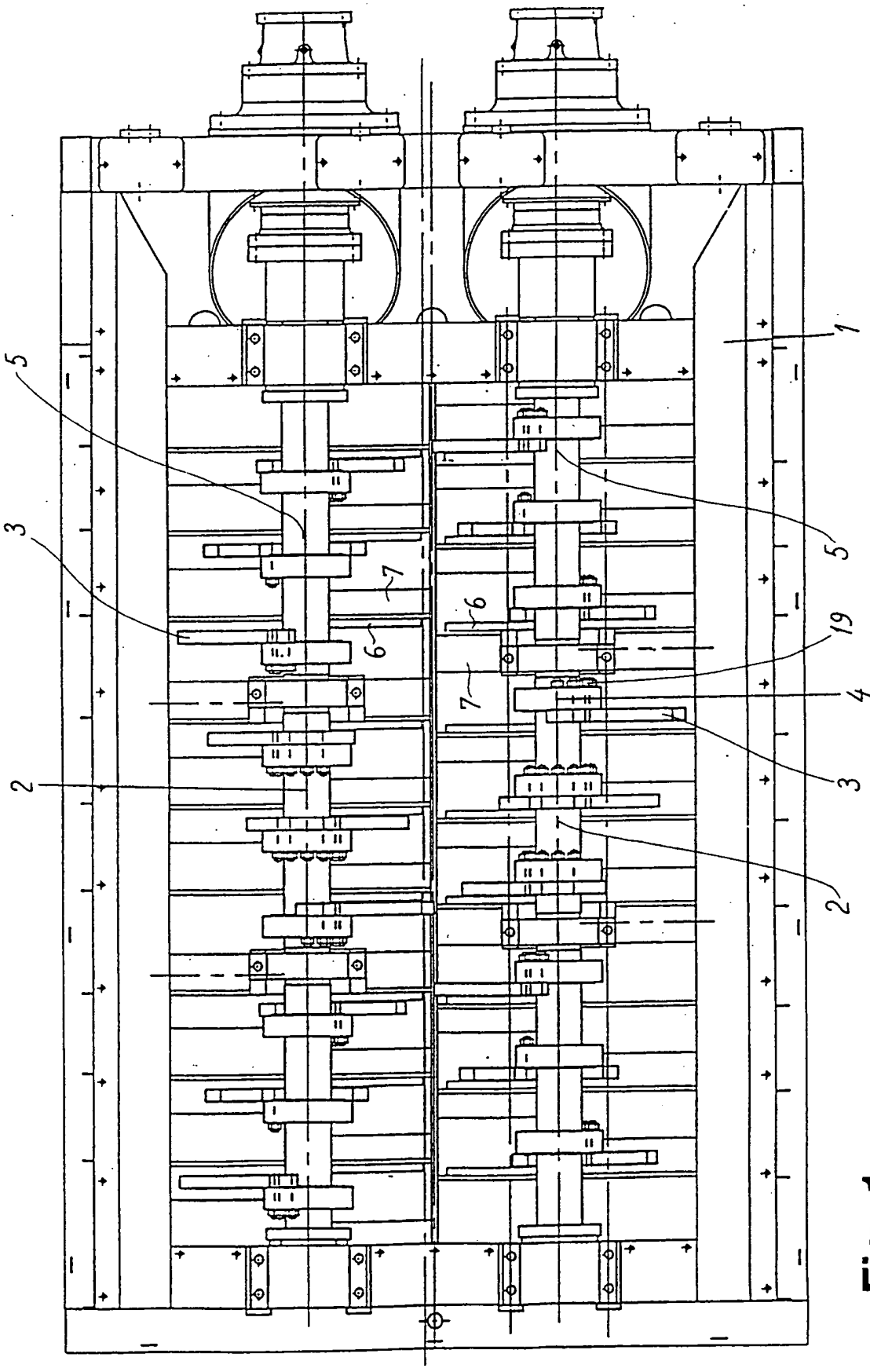


Fig. 1

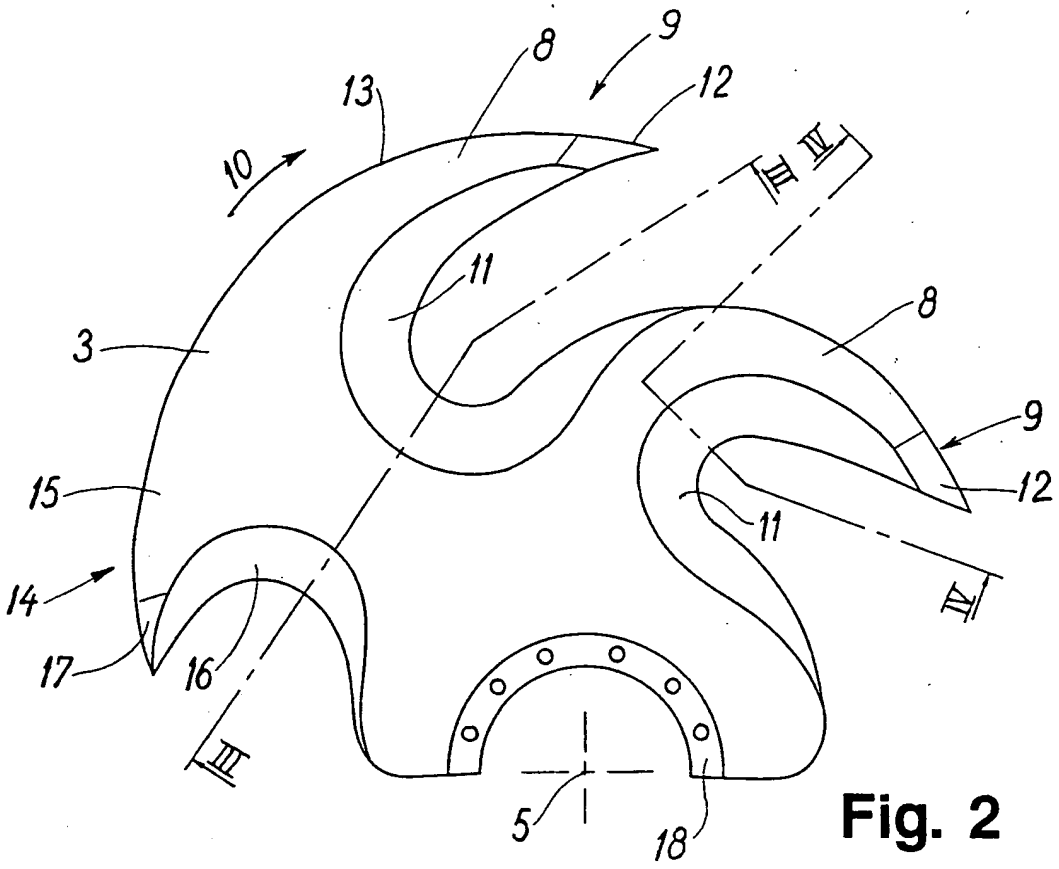


Fig. 2

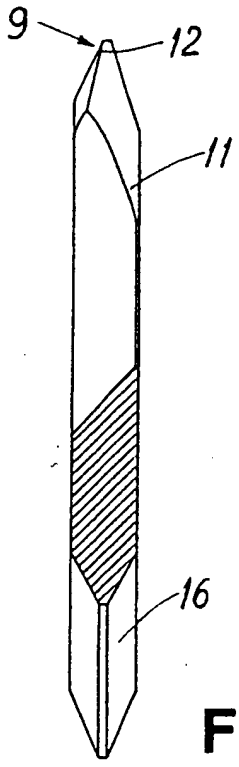


Fig. 3

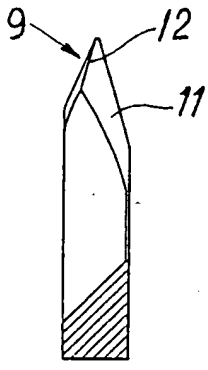


Fig. 4

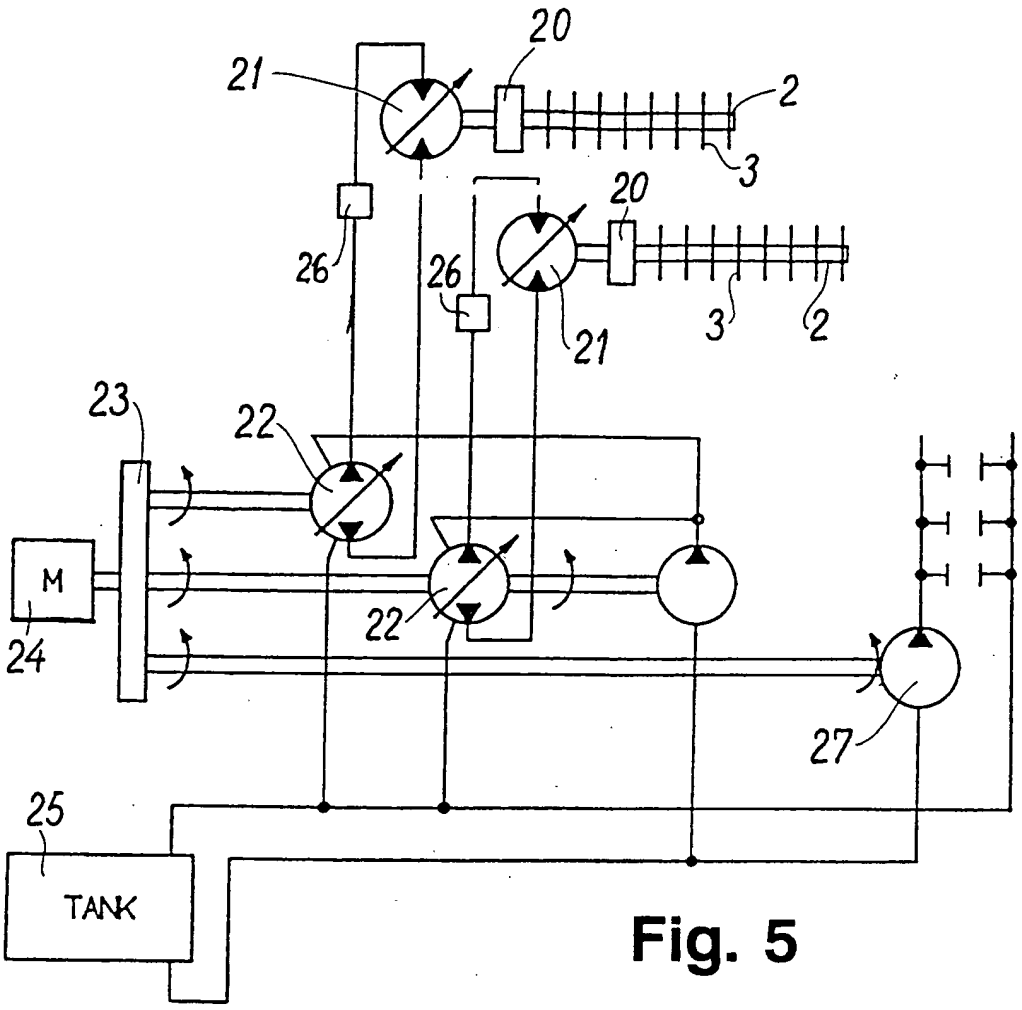


Fig. 5

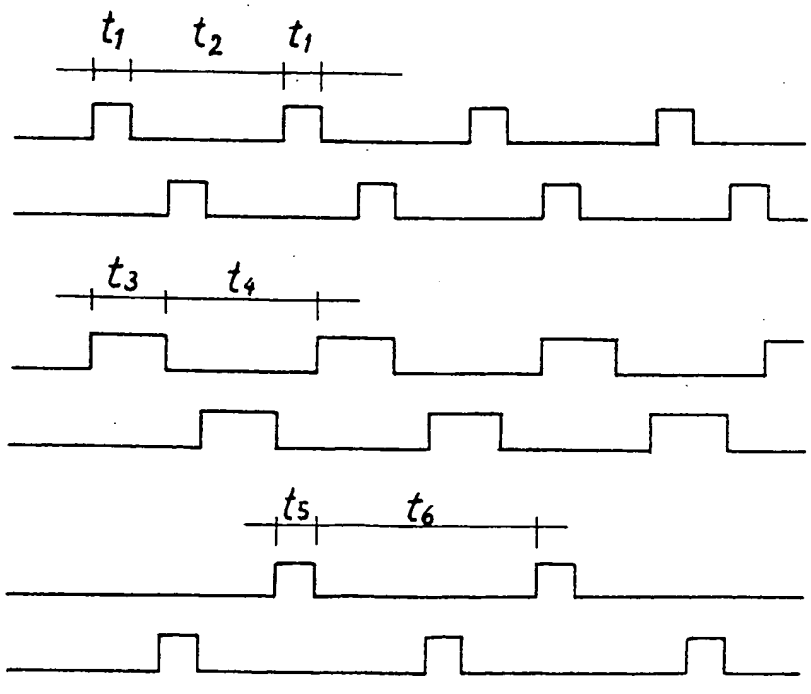


Fig. 6